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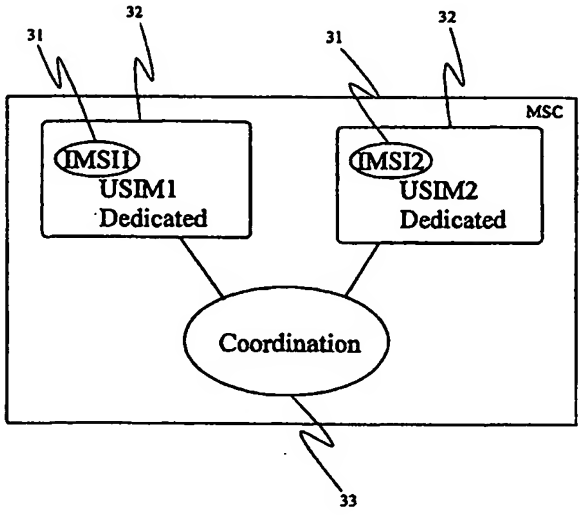

(57) Abstract

The invention disclosed here relates to the management of multiple subscriber identities (31) in one and the same mobile station (MS) in a third–generation mobile communication system. The MM layer in a mobile communication network is arranged so as to be divided into at least two parts in the first of which it is managed the common functions of said subscriber identities (31) and in the second part of which it is managed the subscriber–specific functions of the individual subscriber identities (31). Advantageously a common identity is arranged for the subscriber identities (31) so that said individual subscriber identities (31) may be reached through said common identity. The information of the common identity of said subscriber identities (31) is updated in the mobile communication network e.g, in conjounction with a location update. The information of the common identity may also be updated in conjunction with other corresponding functions.

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Management of multiple subscriber identities

The purpose of this invention is to provide an arrangement for the management of mobile station subscriber identities. The invention finds particular utility in third-generation mobile communication networks, such as the UMTS (Universal Mobile Telecommunication System) in which a mobile station may have more than one subscriber identity.

Fig. 1 illustrates the basic architecture of an UMTS network. Typically, an UMTS network comprises at least one core network CN and one or more radio access networks RAN. A core network CN comprises mobile switching centers MSC and possibly other service nodes. A "node" is here a generic name for network components that take part in the switching; thus it also covers mobile switching centers and other exchange equipment. The radio access networks are located between the core network and terminal equipment. A radio access network comprises base transceiver stations BTS and a radio network controller RNC. Each base transceiver station BTS is connected in a fixed manner with the radio network controller RNC of the radio access network in question. Each radio network controller is in turn connected in a fixed manner with at least one core network node. Other network topologies, such as an IP network or a public switched telephone network (PSTN) may also be connected to core networks.

The general principle of paging in digital mobile communication networks is as follows: When a call has arrived in the node, say a mobile switching center MSC, in which the subscriber is currently registered, the switching center sends a paging request via radio network controllers to those base transceiver stations in the traffic area in whose coverage areas the register data indicate the called subscriber is. The base transceiver stations send a paging message onto the radio path on their paging channels PCH. A mobile station that detects its own subscriber identity on a paging channel which it monitors, sends a response to the base transceiver station. This way the network will know the location of the called subscriber with an accuracy of one cell, and the data connection can be established. In this description and in the claims attached hereto, "data connection" refers to a connection established for the transmitted signal proper. Conventionally, the most common type of data connection is a voice connection.

In third-generation mobile communication networks, a mobile station may have multiple subscriber identities preferably not unlike the IMSI (International Mobile Subscriber Identity) used in GSM, and it may also have multiple simultaneous data connections under different subscriber identities.

Use of more than one subscriber identity in a mobile station is known as such. For example, telecommunications specification UMTS 32.01 V 3.3.0 (10/1998) describes the use of multiple subscriber identities in a mobile station in accordance with Figs. 2a and 2b. According to a first possible embodiment, one IC card may have several USIM modules, which are applications corresponding to the subscriber identity modules (SIM) used in the GSM system that have IMSI identities of their own as well as encryption keys and algorithms, so that just one IC card is inserted in a mobile station, as shown in Fig. 2. According to another embodiment, each USIM module is on an IC of its own. In that case the mobile station must have a sufficient number of IC card locations according to Fig. 2b so that a desired number of USIM modules can be installed in the mobile station.

The use of multiple subscriber identities causes problems. A fundamental problem is that the mobile station, while in the idle mode, has to listen to more than one paging channel PCH. Furthermore, in a situation in which a connection has already been established to a subscriber identity in the mobile station, the mobile station will go on listening to the paging channel because of the other subscriber identities. Such an arrangement wastes resources in unnecessary monitoring of the paging channel PCH.

If there is no data connection active in the mobile station, then, according to the prior art, an incoming call will always initiate the paging process described above. If the mobile station is having a data connection through a node in the core network under a subscriber identity, and a call associated with another subscriber identity arrives at a second node of the core network, the normal paging process will be started as well. In this procedure, each mobile station subscriber identity is handled separately. The drawback of the method is that in principle the signaling capacity of the network is wasted, for the location information of the mobile station is already in the network, and that the mobile station possibly has to monitor several paging channels.

An object of this invention is to provide a method for updating the locations of multiple subscriber identities in one and the same mobile station in a mobile communication network. A second object of the invention is to provide a system for

realizing location management functions for mobile stations using more than one subscriber identity. A third object of the invention is to provide a network element for realizing location management functions for mobile stations using more than one subscriber identity. A fourth object of the invention is to provide a mobile station adapted so as to use multiple subscriber identities.

The objects of the invention are achieved by making all subscriber identities in one and the same mobile station accessible through a single common subscriber identity or corresponding information, thus avoiding the aforementioned problems. Equivalent arrangements are realized in both the mobile communication network and mobile station.

The method according to the invention for managing subscriber identities in a mobile communication network is characterized in that the location management functions associated with a mobile station (MS) are divided into at least two parts of which at least one is reserved as common for the subscriber identities in one and the same mobile station and at least one other part is reserved as separate for the subscriber identities in one and the same mobile station and which subscriber identities in the mobile station are managed through a common identity.

The system according to the invention for realizing location management functions for mobile stations using multiple subscriber identities is characterized in that the system comprises a first element for realizing the common functions of the subscriber identities of each mobile station and at least one other element for realizing subscriber-specific functions of the subscriber identities.

The network element according to the invention for realizing location management functions for mobile stations using multiple subscriber identities is characterized in that the network element comprises a first element for realizing the common functions of the subscriber identities of each mobile station and at least one other element for realizing the subscriber-specific functions of the subscriber identities.

The mobile station according to the invention, adapted so as to use multiple subscriber identities, is characterized in that the mobile station comprises a first element for realizing the common functions of the subscriber identities and at least one other element for realizing the specific functions of the subscriber identities.

Other preferred embodiments according to the invention are presented in the dependent claims.

In accordance with the invention, the mobility management (MM) layer, which includes e.g. the procedures for location area update, attachment and detachment of subscriber identity, authentication and subscriber identification, is divided into two parts, the first of which is a subscriber-specific part (Dedicated MM) and the second of which is a coordinating part (Coordinating MM). With this arrangement it is possible to use the coordinating part for each connection of a subscriber identity in a mobile station for the common functions, such as location management functions, e.g. in such a manner that the core network uses the common identity specified for the individual subscriber identities when paging a given subscriber identity through the coordinating part. Furthermore, by specifying a common identity for all subscriber identities in one and the same mobile station it is possible to use just one paging channel for locating the subscriber identities in question. In a first solution, the common subscriber identity may be the mobile station's equipment identity. In a second solution, the common subscriber identity is one of the subscriber identities of the mobile station which can then be used to access the other subscriber identities. An advantage gained by these solutions is that they make possible the simultaneous registration of a subscriber in multiple network nodes, such as e.g. in a mobile switching center MSC and serving node SGSN in such a manner that no coordination takes place between the nodes since the subscriber identity data have been stored in the home location register HLR. The dedicated part of the MM layer is used for functions associated with a particular subscriber identity. Location update for the subscriber identities in a mobile station can be realized e.g. in such a manner that each subscriber identity updates its own location through the mobile station and there is no coordination between the subscriber identities. A location update request for subscriber identities preferably includes information about the subscriber identity in question and an indicator to indicate whether there are subscriber identities still in the mobile station the locations of which should be updated. In accordance with another embodiment, there is coordination between the subscriber identities, whereby a network element has knowledge of all the subscriber identities in the same mobile station, which knowledge is updated in connection with location update and when the mobile station is switched on. Advantageously, coordination means e.g. that the core network CN of the mobile communication network knows how multiple subscriber identities in one and the same mobile station are managed.

The invention is below described in more detail referring to the accompanying drawings in which

Fig. 1 shows an example of a network architecture in which the invention is applicable,

Figs. 2a and 2b show an arrangement according to a specification of multiple subscriber identities,

Fig. 3a shows a possible arrangement of the MM layer,

Fig. 3b shows a possible mobile station according to the invention,

Fig. 4 shows a possible operation,

Fig. 5 shows a second possible operation,

Fig. 6 is a conceptual illustration of a location update procedure,

Fig. 7 illustrates an exemplary location update procedure, and

Fig. 8 illustrates a second exemplary location update procedure.

Like elements in the drawings are denoted by like reference designators. Figs. 1, 2a and 2b were discussed above.

Below it will be described a possible arrangement according to the invention of the MM layer as depicted in Fig. 3 for a third-generation mobile communications system from the perspective of the network, in which system it is possible to use more than one subscriber identity 31 in one and the same mobile station MS.

The MM layer is adapted so as to be divided into two parts. The first part is here called a dedicated MM layer 32. Each subscriber identity 31 has a MM layer part of its own which the subscriber identity 31 in question can use. The dedicated MM 32 handles functions related to a particular subscriber. The dedicated MM 32 may be used e.g. to page a certain subscriber identity 31 and to utilize subscriber information in the MM layer of a particular subscriber identity 31. Operation of the dedicated MM 32 corresponds to part of the operation of the MM layer in the current GSM network.

The other MM layer part in this exemplary embodiment is the so-called coordinating MM 33 which is common to all subscribers in one and the same mobile equipment. The common subscriber identity 31 assigned to the subscriber identities 31 of a mobile station MS is used to associate a given subscriber identity 31 with the coordinating MM. In idle mode the mobile station MS can listen to the paging channel PCH through the coordinating MM 33. When the MM layer is active, i.e. when there is a connection to at least one subscriber identity 31 in the mobile station MS, the coordinating MM 33 is used for arranging possible connections for subscriber identities 31 other than the active subscriber identity 31. The use of the coordinating MM 33 for all subscribers achieves at least the advantage that the functions com-

mon to all connections can be handled in that MM part, thus saving resources in the mobile station MS.

In accordance with a preferred embodiment of the invention a system is provided in the network for the realization of location management functions of mobile stations MS having more than one subscriber identity 31, which system advantageously comprises a first element to realize the common functions of the subscriber identities 31 in each mobile station MS, and at least one other element to realize the subscriber-specific functions of the subscriber identities 31. The same can be advantageously realized also by having a single network element in the network, which network element comprises a first element to realize the common functions of the subscriber identities 31 in each mobile station MS, and at least one other element to realize the subscriber-specific functions of the subscriber identities 31 so that the location management functions of mobile stations MS having multiple subscriber identities 31 can be realized. Such a network element may be e.g. a mobile switching center MSC together with VLR (Visitor Location Register) and HLR registers or a radio network controller RNC.

Let us next consider an arrangement for multiple subscriber identities 31 in one mobile station MS. Advantageously, a common identity is provided for the subscriber identities 31 such that each individual subscriber identity 31 can be accessed through the common identity.

According to a first arrangement of the invention the equipment identity of the mobile station MS may be used as the common identity of the subscriber identities 31 in a mobile station. Advantageously the equipment identity is in this arrangement the so-called IMEI (International Mobile Equipment Identity) code by means of which every mobile station MS can be identified. The subscriber identities 31 must be bound, using a known technique, to the equipment identity in question. One such technique could be e.g. one in which an arrangement is realized in the HLR whereby the subscriber identities 31 of a mobile station MS are bound to the equipment identity. The arrangement may be implemented in the form of a database arrangement, for example. When all subscriber identities 31 in one and the same mobile station MS have been bound to the equipment identity, the location functions of all the subscriber identities 31 in the mobile station MS can be carried out using the equipment identity in question which serves as a common identity in the coordinating MM 33.

The arrangement described above has many advantages. One of the biggest advantages is that the arrangement based on the equipment identification of a mobile station MS is applicable both when the USIM modules are on one and the same IC card and when the USIM modules are on multiple IC cards. Replacement of USIM modules in a mobile station MS can be done easily since advantageously the USIM cards in the mobile station MS can be dynamically updated in the HLR. What is meant by this is that as soon as the mobile station MS detects a new subscriber identity 31 it updates the information in the HLR according to the current status. It is obvious to a person skilled in the art that if a mobile station MS includes only one USIM module, the procedure is advantageously the same as in current digital mobile communication networks, such as GSM. Furthermore, use of the equipment code of the mobile station MS has the advantage that the code in question can be used in the encryption of possible connections. Encryption of the connections of all subscriber identities 31 can be realized using a single encryption key so that every connection does not require encryption of its own.

It is obvious to one skilled in the art that the solution disclosed here is based on the use of a common identifier which is permanently stored in the HLR. Use of a permanent common identifier stored in the HLR, as compared to the use of a temporary identifier, such as the TMSI (Temporary Mobile Subscriber Identity) used in the GSM system, has the advantage that possible loss of identifier data in the VLR, say in the case of a so-called VLR_Restart, will cause no problem. This is due to the fact that in the case of a common identifier the common identifier data are stored in the HLR, too, from where they can be transferred back to the VLR so that establishment of connection will succeed normally. The problem with using a temporary identifier is that if the data are lost in the VLR while the mobile station MS is listening to the paging channel PCH, no connection can be established on the basis of the temporary identifier because the network does not have the temporary identifier data. Therefore, the use of a temporary identifier requires additional coordination between the different network elements, which is not necessary in the solution according to the invention.

According to another arrangement of the invention, in a case where multiple subscriber identities 31 are associated with a mobile station MS in such a manner that multiple USIM modules are placed on one and the same IC card, one of said subscriber identities 31 can be considered the primary USIM identity. The primary subscriber identity 31 is specified in advance in the mobile station MS. Operation of the primary subscriber identity 31 can be arranged in at least two ways as follows.

First, the primary subscriber identity 31 may be in the same position as the other subscriber identities 31 in the mobile station MS, i.e. normal services of a service provider are associated with the primary subscriber identity 31. By means of the primary subscriber identity 31 it is possible to page the other subscriber identities 31 through the coordinating MM. If the primary subscriber identity 31 is used in such a manner that services of a service provider are associated with it, a temporary subscriber identity 31 is used for encrypting the subscriber identity when the primary subscriber identity is paged. In another arrangement, no services of a service provider are associated with the primary subscriber identity 31 but one important function of the primary subscriber identity 31 is to provide encryption to the other subscriber identities 31 in the same mobile station MS. This way, the subscriber identity 31 information of subscriber identities with which services have been associated, need never be transmitted unencrypted over the radio path.

In a preferred embodiment of the invention a mobile station MS is adapted so as to use multiple subscriber identities 31 e.g. in such a manner that the mobile station MS comprises a first element 34 to realize the common functions of the subscriber identities 31 and at least one other element 35 to realize the specific functions of the subscriber identities 31.

When a USIM card is changed in a mobile station MS the subscriber identity information has to be updated in the VLR and HLR. This can be done e.g. in such a manner that the mobile station MS sends an update request, for example, to the VLR of the mobile switching center. The request comprises the following information fields: IMSI (International Mobile Subscriber Identity), TMSI and IMEI. In addition to the IMSI and TMSI information contained in the request used in the current GSM network the request includes a new information field, i.e. the IMEI field which indicates the common identity of all subscriber identities 31 in the mobile station MS. The VLR updates the information in the HLR in such a manner that it sends, using e.g. the MAP (Mobile Application Part) protocol, a known update request which includes, in addition to the IMSI field, the new information, or the common subscriber identity 31, which in this exemplary embodiment is the IMEI code. In another arrangement a new service, or MAP message, can be arranged in the MAP protocol, which service can be called e.g. IMEI_UPDATE, which includes the same information as the above-described update request based on the GSM system. The HLR may advantageously return a value to the VLR, indicating information update in the HLR. The new information field in said MAP message may advantageously be added to all MAP messages that result in actions in

nodes in which coordination as described above is required. One such MAP function could be roaming number inquiry associated with a terminating call. Coordination is important, especially in the case of a VLR_Restart, for instance, in which the common identity information will be lost from the VLR. The arrangement described above can be realized in a case in which the common identity is an individual subscriber identity 31, or primary subscriber identity 31, in such a manner that the information of the first subscriber identity 31 to be transmitted corresponds to the common subscriber identity 31 information. In this arrangement it is not necessary to have a new information field in the update request for the common subscriber identity 31 because multiple USIM modules on one IC card can be considered "more permanent" than e.g. in a case where a mobile equipment may take replacement IC cards with just one USIM module in each. Advantageously, the above-described update arrangement for the information of the common subscriber identity 31 can be realized also when the mobile station MS is switched on. The subscriber identity information update described above may also advantageously be realized in conjunction with location update by providing the corresponding information fields in the location update request in order to transfer the necessary information.

Fig. 4 shows a possible embodiment illustrating how the split MM layer can be utilized when there are multiple subscriber identities 31 in one and the same mobile station MS. The core network CN knows how to manage multiple subscriber identities 31 in one and the same mobile station MS. Let the subscriber identities 31 be bound to USIM modules in the mobile station MS and let them be called IMSI1 and IMSI2. In the first state 41 subscriber identity IMSI2 is paged. Then it is first checked 42 whether said subscriber identity IMSI2 is active, i.e. if the subscriber identity 31 already has a connection. If so, a new connection can be established using the existing signaling channel or the call can be put on hold, i.e. in a so-called call hold/call waiting state CH/CW 43 like in the current digital GSM network, for example. If the subscriber identity IMSI2 is not active it is checked 44 whether the common identity of the subscriber identities in the mobile station MS is active. If the common identity is active the existing connection of another subscriber identity 31 may be utilized 45 e.g. in such a manner that a service request is sent via the existing signaling channel to the subscriber identity 31 paged. If, however, the common identity of the subscriber identities 31 is not active the mobile station MS will monitor 46 the paging channel PCH as usual. Terms used above are not limited to this explanatory embodiment but the arrangement can be applied in other similar situations in which a mobile station MS has multiple subscriber identities 31. It is

obvious to one skilled in the art that while operation was above described solely from the perspective of a mobile switching center MSC, the case is not limited to the arrangement described but the mobile switching center MSC may be replaced by any other possible arrangement such as a radio network controller RNC, for example.

In a situation where the subscriber identities 31 of a mobile station MS are associated with separate core networks CN, as shown in Fig. 1, a common subscriber identity 31 can also in that case be utilized in accordance with Fig. 5. Let in this exemplary embodiment a mobile station MS have two subscriber identities 31 which are here called IMSI1 and IMSI2. These subscriber identities are associated with separate core networks CN the mutual border of which is marked by a dotted line in Fig. 5. At the side of the first core network CN a mobile switching center MSC pages subscriber identities 31 of a mobile station MS, and at the side of the second core network CN a radio network controller RNC pages subscriber identities 31 of the mobile station MS. In the first state 41, subscriber identity IMSI2 is paged. Then it is first checked 42 whether said subscriber identity IMSI2 is active, i.e. if the subscriber identity 31 already has a connection. If so, a new connection can be established using the existing signaling channel or the call can be put on hold, i.e. in a so-called call hold/call waiting state CH/CW 43 like in the current digital GSM network, for example. If the subscriber identity IMSI2 is not active it is checked 44 whether the common identity of the subscriber identities of the mobile station MS is active. If the common identity is active the existing connection of another subscriber identity 31 may be utilized 45 e.g. in such a manner that a service request is sent via the existing signaling channel to the subscriber identity 31 paged. If, however, the common identity of the subscriber identities 31 is not active the mobile switching center MSC in the core network CN transmits a paging message. When the paging message has arrived in the radio network controller RNC, it is checked 51 whether the subscriber identity IMSI2 is active via the second core network CN. If so, a connection can be established using the existing signaling channel 52. But if the subscriber identity IMSI2 is not active, it is checked 53 whether the common identity is active in the second core network CN, say in the serving node SGSN. If the common identity is active, the existing signaling information of the other subscriber identity IMSI1 is utilized 54. But if the common identity 31 is not active, a paging message is transmitted 55. It is obvious to a person skilled in the art that the operation is similar in each core network CN if there are more than two subscriber identities 31 and more than two separate core networks CN.

It is obvious to one skilled in the art that the radio network controller RNC or base station controller BSC is not necessarily able to connect the paging message and response message with each other when the paging message is transmitted on the paging channel PCH, whereby the radio network controller RNC or the like will lose the information of the common identity received in an earlier paging message. Therefore, subsequent to e.g. authentication or other such function the core network CN can advantageously deliver, using e.g. a separate procedure, the common identity information to the radio network controller RNC or the like. As the information has been stored in the network it is possible, as described above, to check 51; 53 the status of a given subscriber identity 31, be it a single or common identity.

Let us consider a situation in which a connection has already been established to a first subscriber identity 31 e.g. from a serving node SGSN located in a different core network CN than e.g. a mobile switching center MSC that sends a paging request to a second subscriber identity 31 in the mobile station MS. Advantageously the arrangement is realized in such a manner that the paging request includes a common identity of the subscriber identities 31 so that the network is able to use the signaling information of the existing connection obtained through the common identity in order to establish the second connection. According to a preferred embodiment the paging message includes at least the following information: the IMSI code and TMSI code of the subscriber identity 31 paged and the common identity 31 information. In an embodiment of the invention the common subscriber identity 31 is the equipment identity as described earlier. It is obvious to one skilled in the art that if the common subscriber identity 31 is an individual subscriber identity 31, or primary subscriber identity 31, the common subscriber identity 31 need not be transferred in the paging request and the IMSI code transferred can be made to refer to the primary subscriber identity 31 and the TMSI code to the actual subscriber identity 31 paged. Furthermore, a node in the core network CN can convey said common identity to a radio network controller RNC to be stored using a separate procedure.

Let us next consider a location update procedure according to an embodiment of the invention for multiple subscriber identities 31 in one and the same mobile station MS. Fig. 6 shows in principle a location update procedure between a mobile station MS and core network CN or a network node. In this exemplary embodiment the mobile station MS has three subscriber identities 31. The location update may be realized e.g. in such a manner that upon location update the mobile station MS transmits a location update request LA_UPDATE_REQ to the core network CN.

The location update request LA_UPDATE_REQ includes e.g. the information of the subscriber identity 31 updating its location and a special indicator. The indicator tells the core network CN node when the signaling connection between the mobile station MS and the network can be terminated. When the location update request LA_UPDATE_REQ has arrived in the core network CN, the authentication of the subscriber identity 31 and other similar functions MM_COORDINATING_PROCEDURES are carried out through the coordinating MM 33. When the location update of the subscriber identity 31 has been carried out in the core network CN, the core network CN sends an acknowledgment LA_UPDATE_ACC to the mobile station MS about the location update of the subscriber identity 31 and remains awaiting the information of the next subscriber identity 31. After having received the acknowledgment LA_UPDATE_ACC the mobile station MS transmits to the core network CN a location update request LA_UPDATE_REQ for the next subscriber identity 31 in the same manner. The indicator value shows that the mobile station MS still has subscriber identities 31 the locations of which have not yet been updated. The same procedures MM_COORDINATING_PROCEDURES as above are carried out in the core network CN and a location update acknowledgment LA_UPDATE_ACC is sent to the mobile station MS. In the location update request LA_UPDATE_REQ for the last subscriber identity 31 the indicator is set to indicate that after the subscriber identity 31 in question there will be no more subscriber identities 31 the location information of which should be updated. Subsequent to the last location update, an acknowledgment LA_UPDATE_ACC is sent to the mobile station MS. By means of the indicator it is possible to inform the core network CN about the fact that the location data of all subscriber identities 31 have been transmitted to the core network CN and the connection can be terminated. It is obvious to one skilled in the art that the aforementioned indicator may be realized e.g. in such a manner that the value of a given bit is monitored and bit value one, for example, indicates that there are still other subscriber identities 31 the location information of which should be updated, and bit value zero, for example, indicates that the location data of all subscriber identities 31 in the same mobile station MS have been updated. It is also obvious to one skilled in the art that a location update request LA_UPDATE_REQ for a given subscriber identity 31 cannot be sent to a network element of one and the same core network CN before an acknowledgment LA_UPDATE_ACC for the update of the previous subscriber identity 31 has been received at the mobile station MS. However, a location update request to another core network CN element can be sent before the other core network CN has acknowledged. In the location update procedure described above, the number of

subscriber identities 31 is not in any way restricted but there may be fewer or more subscriber identities 31 than in the example illustrated by Fig. 6.

Let us next consider the location update procedure in more detail from the mobile communication network's standpoint. In the cases described the mobile station MS has two subscriber identities 31. Fig. 7 shows a possible way of realizing the location update from the perspective of the mobile communication network. The mobile station MS sends a location update request LA_UPDATE_REQ1 to a network node, such as advantageously a mobile switching center MSC, which request is e.g. as described above, i.e. comprising at least a first subscriber identity 31 and an indicator about other possible subscriber identities 31 the location information of which should be updated. The mobile switching center MSC sends the information UPDATE_LOCATION1 of the subscriber identity 31 that requested location update to the HLR register SP_HLR1 of the service provider of the subscriber identity 31 in question. The HLR sends an acknowledgment UPDATE_LOCATION_ACK1 about the location update to the mobile switching center MSC which in turn sends an acknowledgment LA_UPDATE_ACC1 to the mobile station MS. Having received the acknowledgment LA_UPDATE_ACC1 the mobile station MS sends a location update request LA_UPDATE_REQ2 for the second subscriber identity 31 to the mobile switching center MSC, which request is e.g. as described above. The mobile switching center MSC sends the location update information UPDATE_LOCATION2 to the HLR register SP_HLR2 of the service provider of the subscriber identity 31 in question, which here is different than the service provider SP of the other subscriber identity 31. The HLR register SP_HLR2 of the service provider sends an acknowledgment UPDATE_LOCATION_ACK2 to the mobile switching center MSC. The mobile switching center MSC in turn sends an acknowledgment LA_UPDATE_ACC2 about the location update to the mobile station MS. It is obvious to a person skilled in the art that in the case of multiple subscriber identities 31 the service providers SP of the subscriber identities 31 in question may be the same or different or any combination of service providers SP in the market.

Let us next consider location update in a case in which there is coordination between the subscriber identities 31 in a mobile station MS. In this embodiment the idea is that one of the HLR registers of the subscriber identities 31 is arranged so as to function as primary register and the other HLR registers are registers of the service provider SP. The primary HLR contains the information on the subscriber identities 31 in the same mobile station MS. The HLRs of the service provider SP

may advantageously contain the same information as the HLRs of the current GSM system. Such information includes e.g. the IMSI code and the address of the VLR.

Fig. 8 shows a possible solution for location update when there is coordination between the subscriber identities 31. When updating its location, a mobile station MS sends a location update request LA_UPDATE_REQ1 to a mobile switching center MSC. The location update request includes in this exemplary embodiment the information of the primary subscriber identity 31, which is common to all the subscriber identities 31, and an indicator as described above. The purpose of the indicator is to tell that there are in addition to the primary subscriber identity 31 other subscriber identities 31 in the mobile station MS the locations of which should be updated. The mobile switching center MSC sends to the primary HLR register PRI_HLR location update information UPDATE_LOCATION1, which contains the information corresponding to the primary subscriber identity 31. The primary HRL sends an acknowledgment UPDATE_LOCATION_ACK1 about the location update to the mobile switching center MSC which in turn sends an acknowledgment LA_UPDATE_ACC1 to the mobile station MS. Having received this acknowledgment the mobile station MS sends a new location update request LA_UPDATE_REQ2 to the mobile switching center MSC. This request includes the information of the subscriber identity 31 to be updated and an indicator. In this exemplary embodiment there is only one other subscriber identity 31 in addition to the primary subscriber identity 31, so the indicator indicates in this update request that there will be no more location information to be updated. The mobile switching center MSC sends a location update request UPDATE_LOCATION2 to the HLR register SP_HLR of the service provider of the subscriber identity 31 in question. The location update request includes the information of the primary subscriber identity 31 and the subscriber identity 31 to be updated. The HLR register SP_HLR of the service provider sends an acknowledgment UPDATE_LOCATION_ACK2 to the mobile switching center MSC which in turn sends an acknowledgment about the location update to the mobile station MS. In addition, the HLR register SP_HLR of the service provider sends the service information UPDATE_USIM_INFO associated with the subscriber identity 31 in question to the primary HLR register PRI_HLR using the MAP protocol so that the primary HLR register PRI_HLR has the information of all subscriber identities 31 associated with the same mobile station MS.

The location update procedures described above have the advantage that they are nearly compatible with the location update procedures used in the current mobile

communication network. Especially, the location information update of a mobile station MS having multiple USIM modules can be carried out in the network using the current procedures with only slight changes.

The names of different mobile communication network elements and functions used in the description are mainly in accordance with a planned exemplary third-generation mobile communication system which is just an example of a possible application of the invention. Furthermore, the names used in the text that are based on the GSM network are exemplary only, and the same names are here used where applicable when describing the third-generation mobile communication system. It is obvious to one skilled in the art that the invention is not limited to any particular mobile communication system.

Moreover, the above-described functions according to the invention are not in any way restricted but they can be applied in accordance with the requirements of each mobile communication system. It is also obvious to a person skilled in the art that while the description above almost solely deals with solutions in which the mobile station has two subscriber identities, the number of subscriber identities is not in any way limited but one mobile station may have one or several subscriber identities.

The inventional idea disclosed in this publication can be applied in different ways within the scope defined by the claims.

Claims

1. A method for managing subscriber identities (31) in a mobile communication network where one and the same mobile station (MS) uses one or more subscriber identities (31), **characterized** in that the location management functions associated with a mobile station (MS) are divided into at least two parts of which at least one is reserved as common to the subscriber identities (31) in one and the same mobile station (MS) and at least one other part is reserved as separate for the subscriber identities (31) in one and the same mobile station (MS) and which subscriber identities (31) in the mobile station (MS) are managed through a common identity.

2. The method of claim 1, **characterized** in that functions common to the subscriber identities (31) in one and the same mobile station (MS) are handled through at least one MM layer part.

3. The method of claim 2, **characterized** in that the common part of the MM layer is used for the paging of the subscriber identities of a mobile station (MS).

4. The method of claim 1, **characterized** in that in the common part of the MM layer, the equipment identity of the mobile station (MS) functions as the common identity of the subscriber identities (31) in one and the same mobile station (MS).

5. The method of claim 1, **characterized** in that in the common part of the MM layer, the common identity of the subscriber identities (31) in one and the same mobile station (MS) is one of the subscriber identities (31) belonging to the mobile station (MS).

6. The method of claim 1, **characterized** in that said subscriber identities (31) in one and the same mobile station (MS) are paged using one paging channel (PCH).

7. The method of claim 1, **characterized** in that the information about the common identity of the subscriber identities (31) in one and the same mobile station (MS) is stored in a core network (CN).

8. The method of claim 7, **characterized** in that in the core network (CN) the information about the common identity is stored in a HLR register.

9. The method of claim 8, **characterized** in that the information about the common identity is updated in the HLR register.

10. The method of claim 9, **characterized** in that the information about the common identity is updated in conjunction with a location update.

11. The method of claim 9, **characterized** in that the information about the common identity is updated in conjunction with a terminating connection.

12. The method of claim 9, **characterized** in that the information about the common identity is updated in a MAP message.

13. The method of claim 1, **characterized** in that the mobile station (MS) transmits a location update request including subscriber identity information and indicator information indicating whether the location update request has been transmitted for every subscriber identity (31).

14. The method of claim 9, **characterized** in that the location update for the subscriber identities (31) is carried out through the coordinating part (33) of the MM layer.

15. The method of claim 9, **characterized** in that a HLR register corresponding to each particular subscriber identity (31) transmits the location information of the subscriber identity (31) to the HLR register corresponding to the common identity.

16. The method of claim 1, **characterized** in that when paging subscriber identities (31), the paging message includes at least the information about the common identity.

17. The method of claim 1, **characterized** in that when paging a subscriber identity, the paging message includes an IMSI code, TMSI code and an IMEI code.

18. A system for realizing location management functions of mobile stations (MS) having more than one subscriber identity (31), **characterized** in that the system comprises a first element for realizing the common functions of the subscriber identities (31) of each mobile station (MS) and at least one other element for realizing subscriber-specific functions of the subscriber identities (31).

19. A network element for realizing location management functions of mobile stations (MS) having more than one subscriber identity (31), **characterized** in that the network element comprises a first element for realizing the common functions of the subscriber identities (31) of each mobile station (MS) and at least one other element for realizing subscriber-specific functions of the subscriber identities (31).

20. The network element of claim 19, **characterized** in that the network element is a mobile switching center (MSC).

21. The network element of claim 19, **characterized** in that the network element is a radio network controller (RNC).

22. A mobile station (MS) arranged so as to use more than one subscriber identity (31), **characterized** in that the mobile station (MS) comprises a first element (34) for realizing common functions of the subscriber identities (31) and at least one other element (35) for realizing the specific functions of the subscriber identities (31).

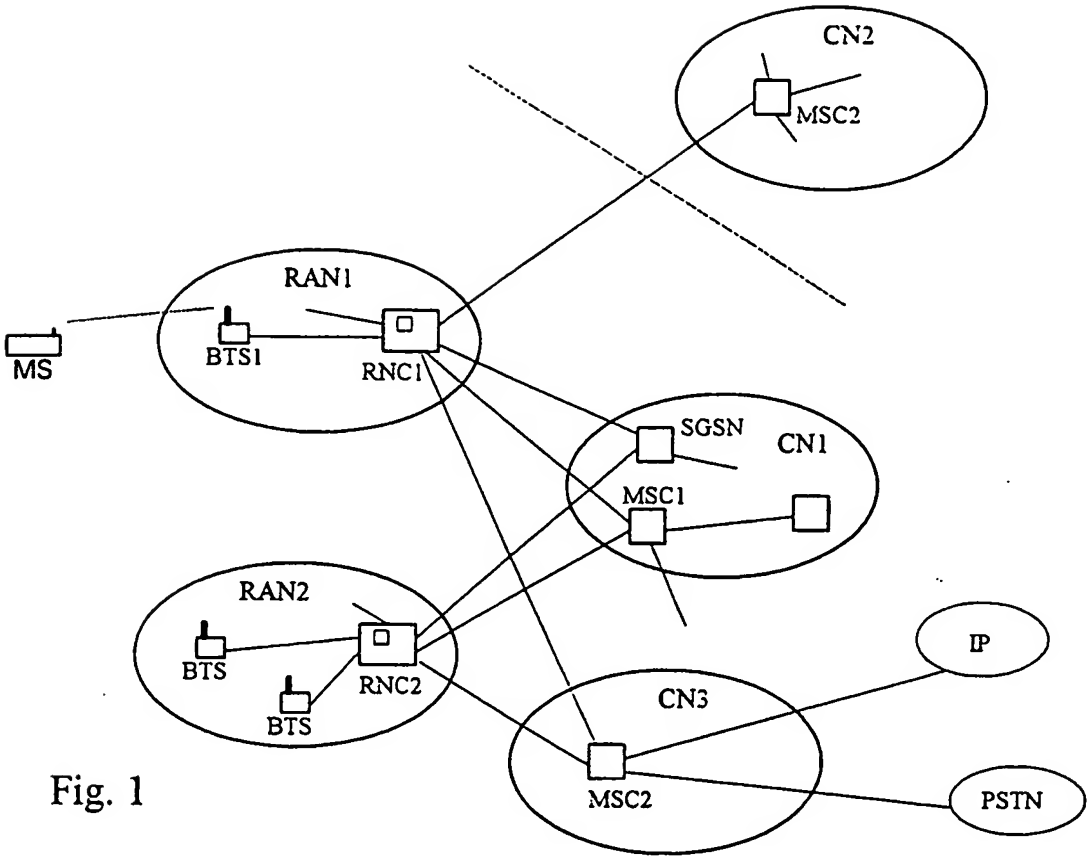


Fig. 1

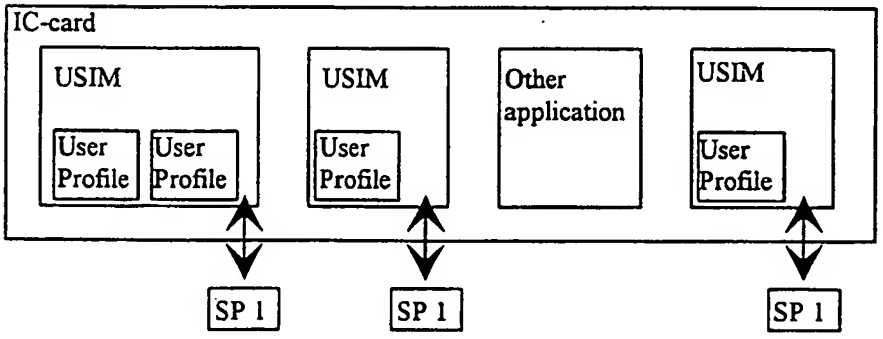


Fig. 2a

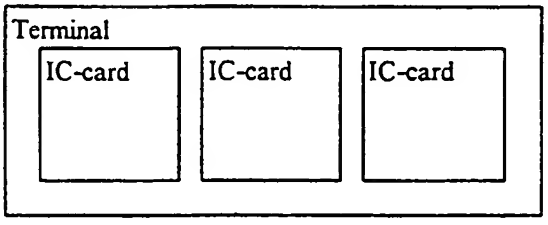


Fig. 2b

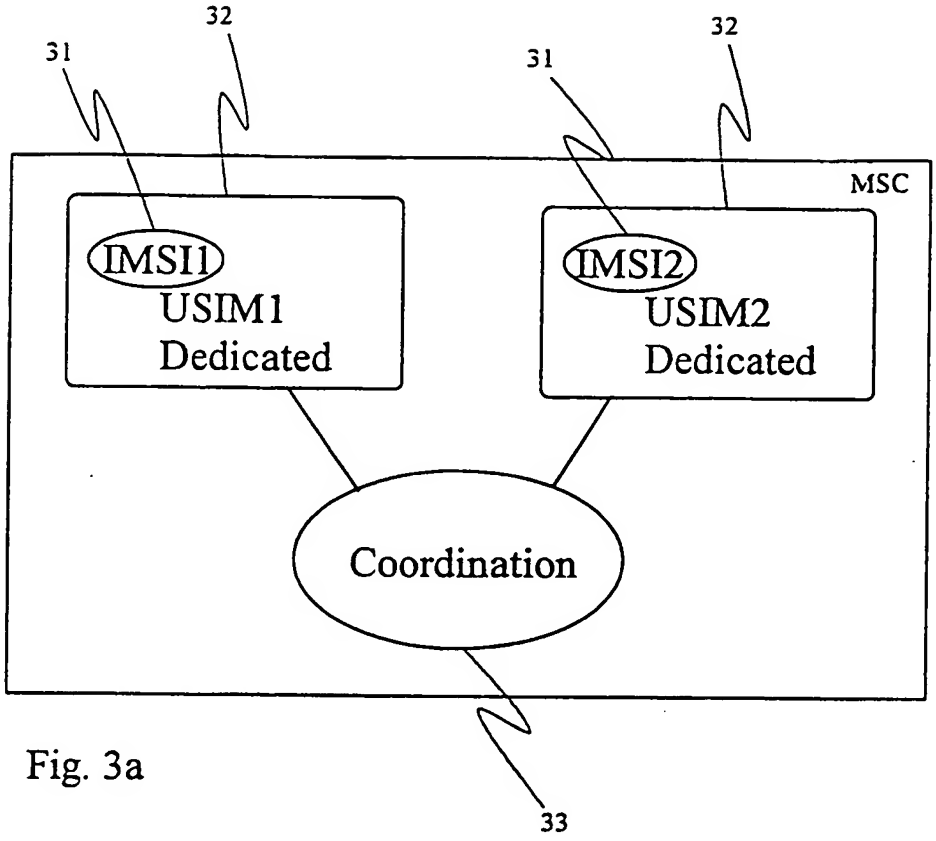

31
32
31
32
MSC
IMSI1
USIM1
Dedicated
IMSI2
USIM2
Dedicated
Coordination
33

Fig. 3a

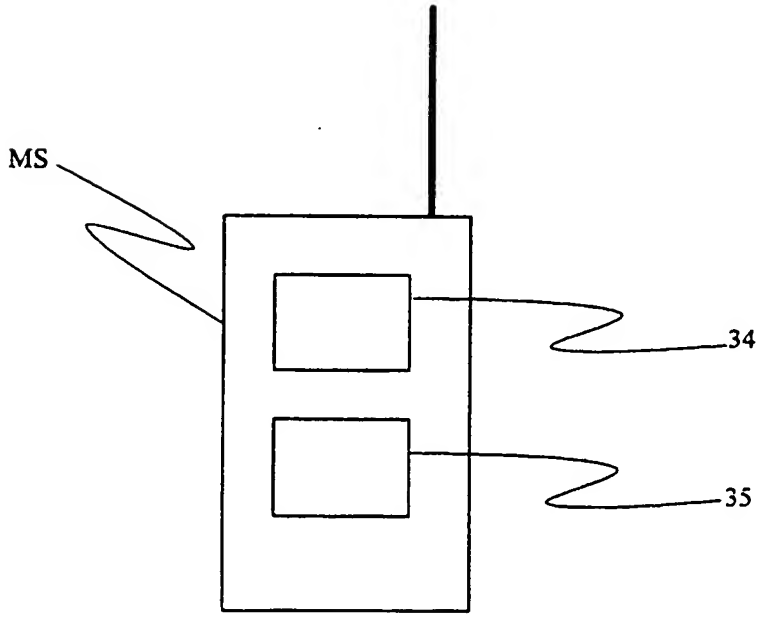
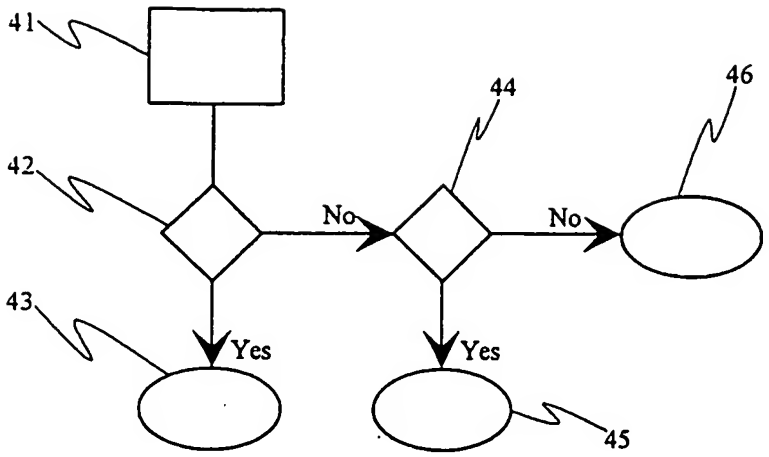

MS
34
35

Fig. 3b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42
43
44
46
45
No
No
Yes
Yes

Fig. 4

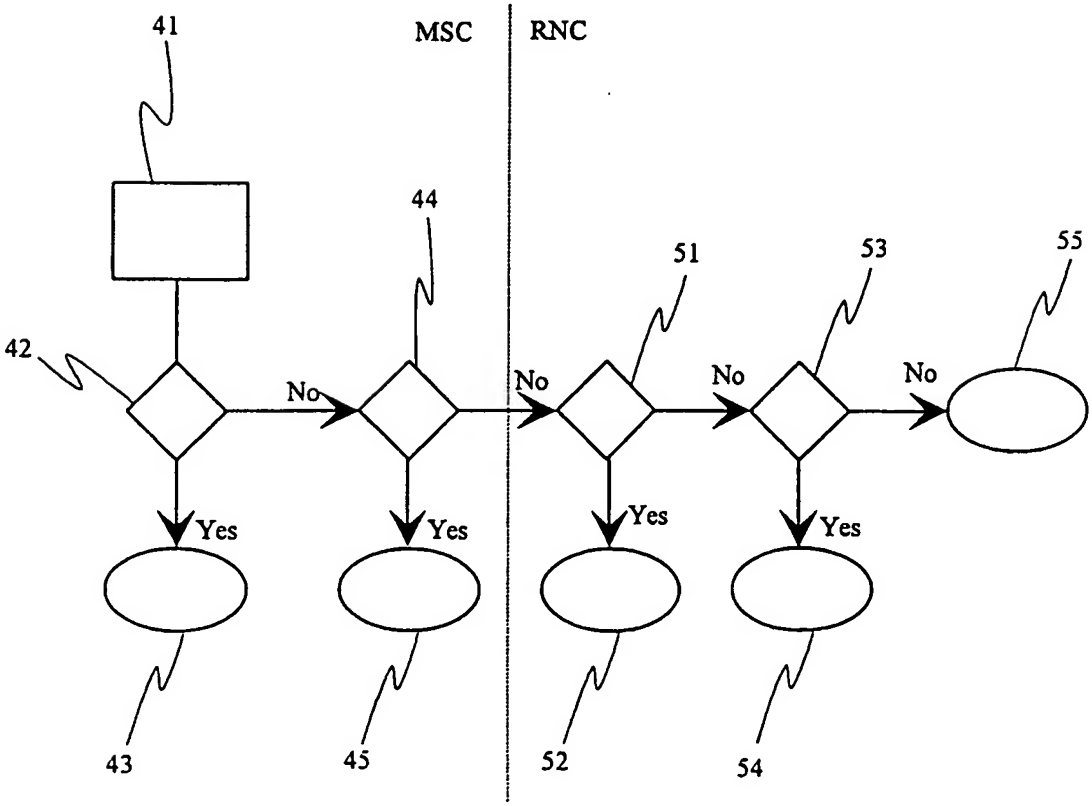
41
MSC
RNC
42
43
44
45
51
52
53
54
55
No
No
No
No
Yes
Yes
Yes
Yes

Fig. 5

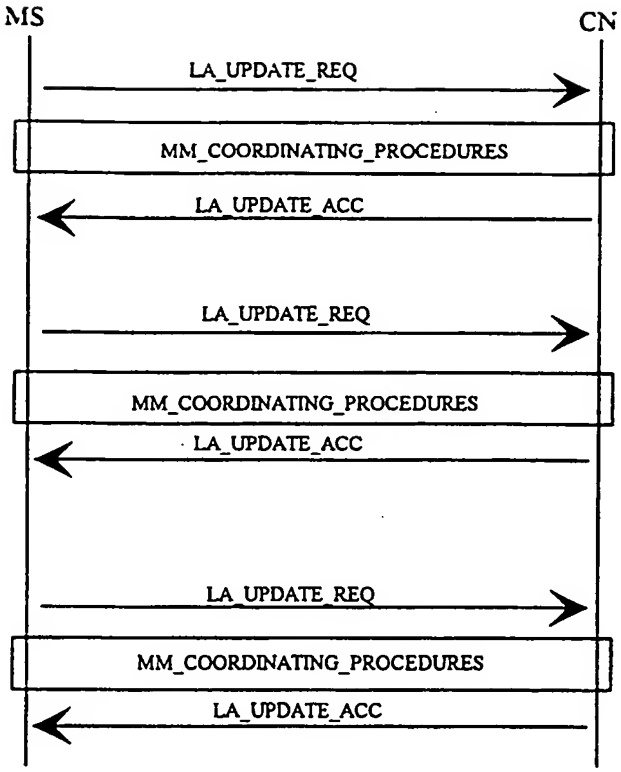
MS
CN
LA_UPDATE_REQ
MM_COORDINATING_PROCEDURES
LA_UPDATE_ACC
LA_UPDATE_REQ
MM_COORDINATING_PROCEDURES
LA_UPDATE_ACC
LA_UPDATE_REQ
MM_COORDINATING_PROCEDURES
LA_UPDATE_ACC

Fig. 6

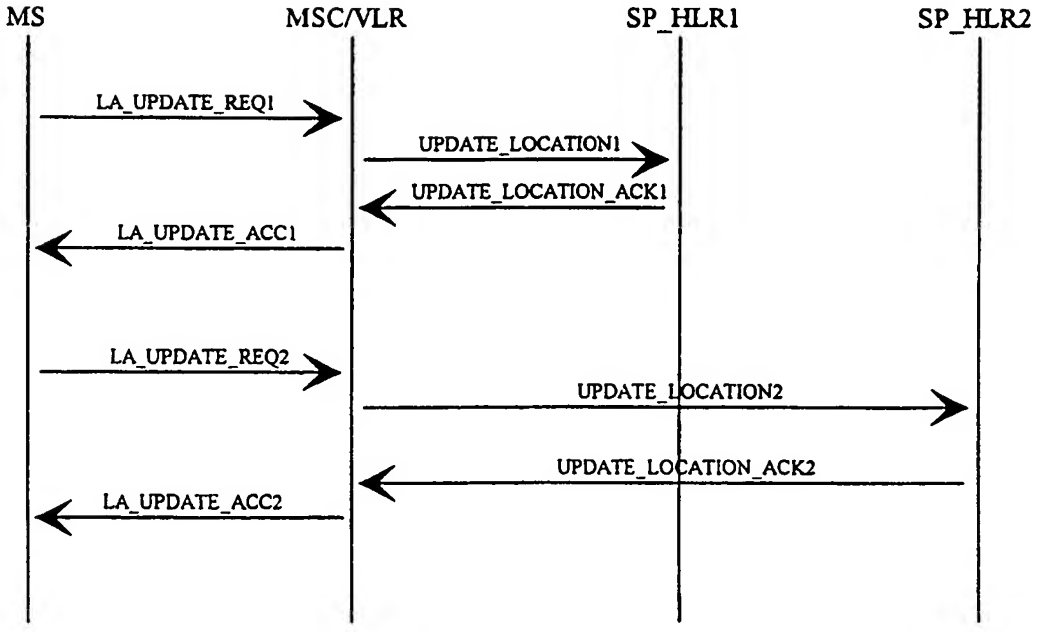
MS
MSC/VLR
SP_HLR1
SP_HLR2
LA_UPDATE_REQ1
UPDATE_LOCATION1
UPDATE_LOCATION_ACK1
LA_UPDATE_ACC1
LA_UPDATE_REQ2
UPDATE_LOCATION2
UPDATE_LOCATION_ACK2
LA_UPDATE_ACC2

Fig. 7

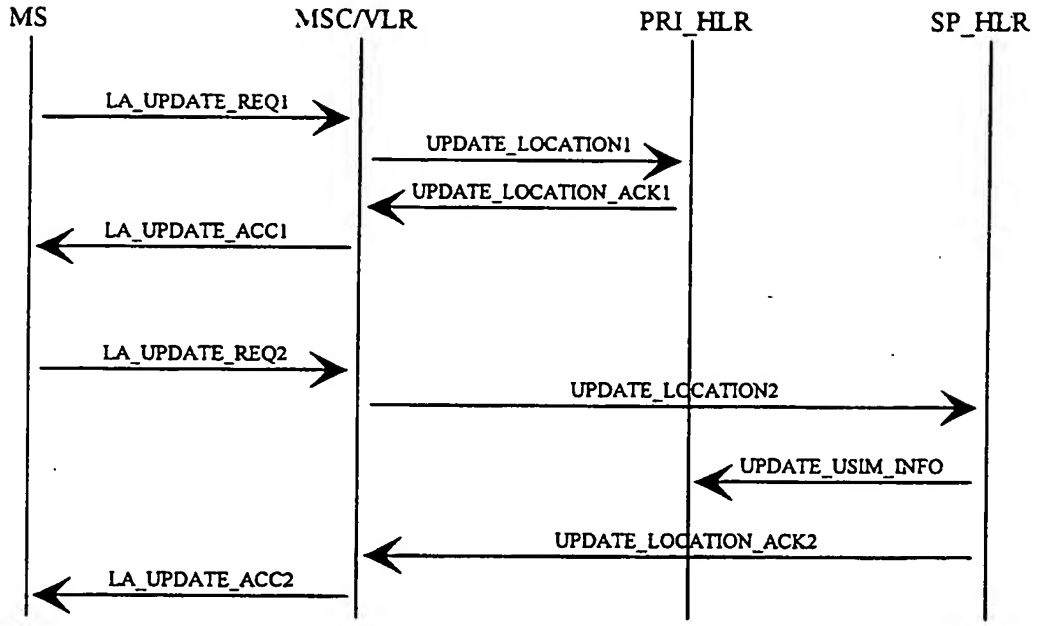
MS
MSC/VLR
PRI_HLR
SP_HLR
LA_UPDATE_REQ1
UPDATE_LOCATION1
UPDATE_LOCATION_ACK1
LA_UPDATE_ACC1
LA_UPDATE_REQ2
UPDATE_LOCATION2
UPDATE_USIM_INFO
UPDATE_LOCATION_ACK2
LA_UPDATE_ACC2

Fig. 8